

Idea signed
Compliments from
the author.

The Importance of Active Muscular Exercise in the Restoration of Function

BY

C. HERMANN BUCHOLZ, M.D.

*Surgeon in Charge of the Medico-Mechanical and Hydrotherapeutic
Department of the Massachusetts General Hospital, Boston;
Assistant to the Orthopedic Surgeon*

Reprinted from the Boston Medical and Surgical Journal

Vol. clxi, No. 7, pp. 212-216, Aug. 12, 1909

BOSTON

D. C. HEATH & COMPANY

120 BOYLSTON STREET

1909

BUCHOLZ

WELLCOME INSTITUTE LIBRARY	
Coll.	welMomec
Coll.	pam
No.	WB 460
	1909
	B92i



22500654299



THE IMPORTANCE OF ACTIVE MUSCULAR EXERCISE IN THE RESTORATION OF FUNCTION.*

BY C. HERMANN BUCHOLZ, M.D.,

*Surgeon in Charge of the Medico-Mechanical and Hydrotherapeutic
Department of the Massachusetts General Hospital, Boston;
Assistant to the Orthopedic Surgeon.*

SPORTS and gymnastics are rightly considered as essential factors in promoting the public health, and not everywhere are they so lightly valued as in this country. State and commonwealth have the greatest interest to encourage their development, because they help to build up the youth; they are by far the best source from which adults may gain strength; they invigorate the old people.

Sports require perfect health of the mind and body, but whenever the function of any organ is injured, people are usually not able to derive any benefit from them, and even great harm may be done. But that which is of advantage for the healthy body is also a most favorable adjunct in the restoration of the injured function. That part of medical art and science which deals with the therapeutic use of exercises is called mechanotherapy, or medico-mechanics, and we use this term to refer to active and passive exercises, massage and to some modern methods of hyperemic treatment.

There is a distinct difference between the active exercise and the other mentioned methods. While these latter depend either upon the hand of

* Read at the annual meeting of the Suffolk District Medical Society, April 24, 1909.

the operator or upon instruments, active exercise makes use of the function of the organ itself.

Deutschländer, in an article on the treatment of fractures by early movements, proposes, as a name for this method, the term "functional treatment" with good reason, because he uses the function of the broken arm or leg to cure the fracture and to restore this very function. But we may go even farther and use this term "functional treatment" for the whole system of active and active-passive exercise and resistance movements.

There is a wonderful power of regeneration in the human body, and it is perhaps one of the greatest problems of medical science to investigate this capacity, and of mental art to make the greatest possible use of it. Active exercise is entirely based upon this principle. Its therapeutic use, therefore, demands definite physiological and pathological indications and requires careful clinical and experimental study. There are in this field many questions still open; others have been satisfactorily answered. We shall here consider to what extent active exercise may be used in the restoration of function and how much we may expect from it.

Let us begin with the influence of exercise upon the muscles themselves. We shall also examine the relation of nervous and muscular function and the effect of functional treatment in lesions of joints and bones. Finally, the importance of active exercise in the diseases of the circulatory system and some other internal diseases will be considered.

I. MUSCLES.

It is an experience of daily life that muscles become bigger, firmer and stronger by training. The enlargement of the muscle is due to an increase in number and size of the fibers. More

important than the anatomical change is the physiological change shown by the increased strength and endurance. Our experimental methods are still at present too crude to enable us to determine exactly how much this increase of strength and endurance is due to some peculiar changes in the muscular tissue and how much to other factors, such as the nervous tone. As a matter of fact, we cannot always distinguish microscopically between fibers taken from a strong or a weak muscle.

Treves, in one series of his ergographic experiments, which consisted in lifting a weight through a certain excursion, has shown that the maximum weight which could be raised only for a few times was, in the beginning of the experiment, 35 kgm., and the minimum weight which could be lifted for a considerable time through the same excursion was 11 kgm. After four weeks' practice, the maximum weight was increased to 40 and the minimum weight to 29 kgm.

These results of exercise, so evident under normal conditions, are still more striking in pathological cases, as shown by the tape measure and the dynamometer. Such observations we make daily on our patients who show atrophy due to inactivity and similar conditions. Here the superiority of active exercise over massage cannot be questioned.

While often the problem is comparatively simple, in certain cases it may be very difficult and complicated.

Prescribing proper exercises may require a thorough understanding of the pathological conditions and mechanical factors. This is particularly true in the so-called corrective exercises, as we use them in the treatment of lateral curvature, flat-foot and other orthopedic deform-

ities. The indication is to restore the normal balance of the antagonistic muscles by strengthening certain groups. In the complicated mechanism of the spine, careless exercise may do a harm which is greater in degree than any improvement which may be gained by correct exercise. This is perhaps the reason why the functional treatment of lateral curvature is not so generally adopted as it should be. The best orthopedic surgeons, however, including *Hoffa*, *Lange*, *Lovett*, *Schulthess*, *v. Mikulicz*, maintain that active exercise is the best method, which should never be entirely neglected in any case of scoliosis.

II. NERVOUS SYSTEM.

Having considered the effect of exercise upon the muscles themselves, we will now turn our attention to the effect which such exercises produce upon the nervous system.

A few physiologic remarks may be helpful in understanding indications and methods. Modern theories, according to *Waldeyer*, *Goldscheider*, *Jacob* and others, teach us that the nervous system is composed of a multitude of neurons. Any stimulation affecting the endorgan of one neuron, if strong enough to be above the neuron threshold, not only excites this individual neuron, but its excitation acts in turn as a stimulus upon the next neuron and so on.

The passing of a stimulus through the nerve cell and the transition of the stimulus from one neuron to the next finds a certain resistance which results in a diminution in the strength of the stimulus and in the rapidity of its passage. Normally, and still more so under pathologic conditions, this resistance is variable. One stimulus breaks the way for the next, and the continuation

of stimuli along the same path finally makes the way smoother, lowering the resistance, as we might say, or, in more technical language, reducing the neuron threshold. In all exercises we see this physiologic law work; by practice movements become stronger, quicker and more precise, and words that are well known are read more quickly. Still more striking examples are seen in pathologic conditions, as, for instance, in the hyperesthetic skin, where repeated pricks with the needle, at first slightly felt, produce finally a disagreeably painful sensation.

For the preservation of the normal condition of the nerve cell, a certain amount of stimulation is necessary. When for a time, for any reason, no stimuli pass through the neuron, degenerative changes take place. One of the most striking examples of this is seen after amputation of a leg in the atrophy of certain cells in the ventral horns and even in their contact neurons of the lateral columns.

There is a very intimate connection between the motor and sensory parts of the nervous system. Motion causes stimulation of the sensory nerves in the joints, tendons, muscles and skin and so produces perception of motion, localization, force and tension. These perceptions allow the brain to control motion, localization, etc., in the brain. (So it is evident that the conception of motion is an acquired function of the brain. *A priori*, there are not such conceptions present; the new-born baby must learn intended motions; it has no control over its motions.)

The conception, on the other hand, allows the will to act on the appropriate organs in the appropriate manner. The product of this action is the motion, which stimulates the sensory nerves, causes the perception of the motion and so results

in proper control of the performance. The perception leads to the conception, as we have found, thus making a complete circle. On the integrity of this circle depends the right performance of voluntary motions. Any disturbance, either central or peripheral, interferes with correct action.

On these physiologic theories we base our treatment by exercises of such disturbances of the nervous system as involve the motor organs. These principles must be kept in mind more or less under all circumstances. We have shown that the chief physiologic points to bear in mind are, firstly, the condition of the neuron threshold which may be altered by pathologic processes; secondly, the necessity of stimulation for preservation of proper function of the nerve cells; and thirdly, the relation of motor perception and conception to motor action. Practically, we cannot distinctly separate these various points, but we should at least bear them in mind in treating patients.

In the treatment of disturbances of motor function, we have to deal with some break in the circle referred to above. In most cases abnormal conditions of the neuron threshold play a great rôle in the break. Consequently, our treatment in the majority of cases will be directed to such methods as will raise or lower this threshold in accordance to the indication.

In cases of paralysis, it is evident that for a considerable time stimuli of normal quantity and quality have not been sent from the motor centers to the muscles, the result being that the paths, so to speak, have grown indistinct, and there is now an abnormal resistance. Therefore, the treatment must be directed to again breaking out the paths and lowering the resistances.

It is understood, of course, that the prognosis will depend upon the degree of real destruction of the nerve tissues. But in many cases we cannot measure this beforehand; hence it always behooves us to make a trial. To each case must be given special care and study. Without going into details, the following are some of the most useful methods:

1. Associated movements; we use them in hemiplegia, where we instruct the patient to make the same motion at the same time with the healthy and affected limb.

2. The imitation method; the operator demonstrates a certain motion; then, by the aid of passive motion, he makes the patient repeat, until the patient is able to do it himself.

3. Another method is to make use of the galvanic current. The electrode is placed on the paralyzed muscle and the patient asked to contract the muscle coincidently with the make and break of the current. At first the current must be strong enough to cause a real contraction of the muscle, and later it can be diminished as the muscle begins to take up work for itself.

4. The kineto-therapeutic method, which consists in active and active-passive exercise while the patient is lying in the water. The lessened weight of the limbs will allow motion to be made more easily and more correctly in the water than outside.

We have other cases quite opposite to the above, where the threshold is abnormally low, giving rise to great irritability, such as is seen in the occupation neurosis. The treatment here must be directed to a raising of the neuron threshold and must naturally be accomplished by somewhat different methods. We need, then, recourse to a combination of rest and exercise.

The desired rest may be accomplished by the use of splints or by imbedding the hand in sand, and a special exercise must be prescribed which educates the muscle and at the same time avoids such movements as cause the original irritation.

Closely connected with these methods are the so-called co-ordination exercises recommended by *Frenkel* in 1890 for the treatment of motor ataxia. Many satisfactory results have been reported in a disease which was considered to have an absolute bad prognosis. We will not go into the details, but it may be added that the essential is active movement prescribed in special forms which are susceptible to various modifications.

III. JOINTS AND BONES.

The importance of mechanotherapy for the restoration of the injured function of the joints is generally acknowledged, and it is hardly necessary to discuss it here. However, the special value of active exercise and its advantage in many cases over massage and passive exercise or forcible manipulation is not sufficiently recognized. In a case, for instance, of Colles' fracture, treated for several weeks with splints only, the wrist and more or less all joints of the hand and fingers are limited in motion and swollen. There is found also alteration in the tendon sheaths and the peritendinous tissues. The muscles have lost their normal tone and tension. Although we use in such a case massage and passive exercise, we should consider them always as factors of secondary value and not neglect active exercise from the very beginning. The more injured the hand has been, the more urgent is this indication. The following are the special advantages of the active exercises: They are by far the best way to increase tone and strength of the muscles; they

have a mechanical effect on the tendons, the function of which can be improved but never entirely restored by massage. The most important effect which active exercises produce is the restoration and maintenance of normal joint action. This is less perfectly accomplished by passive motion, although we must often make use of the latter.

Active movements, therefore, are valuable in restoring the function of joints, by their early use preventing much of the loss of function which results from long use of fixation methods. Let us briefly consider their application in the treatment of fractures, dislocations and joint lesions.

It has been for many years, and it is still with many physicians, both in this country and abroad, dogmatic to treat fractures by fixation until bony union has taken place. The extension method allows the use of exercises to a certain extent. *Bardenheuer*, who has chiefly developed this method in fractures of the humerus, for example, begins with movements on the third day.

Lucas Champonnière first (1897) recommended the use of massage and early movements in certain fractures either alone or in conjunction with fixation, which, however, he regards as auxiliary. In Germany, *Deutschländer*, especially within the last few years, has obtained remarkable results by this method. Not only did the x-ray show that his results were as good as those obtained by fixation, but by such methods he shortened the time and prevented the great loss of function often seen in fixation methods. The reasons which he gives for the early use of massage and exercise are the following: They hasten the resorption of hematomas in the joints and tissues; they furnish the stimuli which prevent

muscular atrophy. Furthermore, in support of his method, *Deutschländer* points out that in the process of development it is the functioning of muscles and joints which determines to a great extent the development of the bones into those forms best suited to the required purposes. In this same way proper exercise can be made to aid in the accurate reduction of the fragments and in the modeling of the callus.

Such methods have their limitations, of course, and are not applicable to all fractures. Only the physician with his knowledge of anatomy and mechanical physiology can make use of it.

However, even if we cannot allow ourselves to be as radical as *Deutschländer*,— and there is some possible just criticism,— we can, with sensible limitations, make good use of his principles.

In uncomplicated dislocations functional treatment from the beginning has an especially practical application. Moreover, here it is perfectly evident in many cases that there is no good reason for the prolonged fixation treatment often used. Experience shows that it is not sufficient to leave such exercises to the patients. It has been said that such early treatment causes much pain. That depends to a great extent upon the way in which it is done; at all events, however, the pain in such slow movements with the careful help of the physician is not so great as in cases of joints already stiffened, when we have to stretch the contracted muscles, ligaments and capsules.

Admitting the usefulness of functional treatment in ordinary stiff joints, its application in infectious arthritis is questionable during the acute stage. The main objections are that the pain may be too great and the inflammation may be increased. My own experience is somewhat limited, but I have been much surprised to see

how little pain is caused even in inflamed joints by proper use of active exercise with assistance. The few cases so far treated in this way have done so well as to warrant its further trial. In no case have we seen any aggravation of the inflammation, while the function has always been very much improved. I do not recommend this method as the sole treatment, but I believe it may be used in connection with rest and other methods whose usefulness have already been demonstrated, such as Bier's congestion, the use of vaccines, and others.

Arthritis deformans has always been a crux medicorum, its prognosis doubtful with all methods of treatment. Some physicians advocate medico-mechanical treatment and, theoretically at least, active exercises, stimulating the nutrition as they do, ought to be of advantage. More experience is necessary before anything definite can be said on this subject.

In a paper of this kind it is impossible to make a complete list of all the conditions which may be benefited by functional treatment. And without stopping to discuss its use in sprains, bursitis, etc., I would like to emphasize finally the application of active exercise in relation to *Julius Wolff's* transformation law.

IV. THE CIRCULATORY SYSTEM.

Most of the effects pointed out in the foregoing parts are in close connection with the increased circulation caused by the action of the muscles. Well-known physiological experiments have shown that dilatation of the arteries and veins in the muscle and in its neighborhood takes place while the muscle is working, and that also the rate of flow at least in the veins is increased. Also in lymph vessels the rate of flow is augmented.

These changes in the local circulation are required to produce the increase of metabolism which is necessary for the growth of the muscle substance and for the resorption of waste products.

Furthermore, among the physical therapeutics used in the treatment of circulatory diseases, active exercises in different forms have played a great rôle. The following are the theoretical principles considered in the application of active gymnastics. The dilatation of the blood vessels over a large area should cause theoretically a lowering of the general blood pressure. But our observations on man and dog show that in strenuous work the pressure is lowered only for a few minutes and afterwards is raised to often a remarkably high degree. This compensation is explained:

1. By reactive contraction of the vessels in other parts, especially of the intestinal arteries and veins.

2. By the increased respiration produced by the necessity for more oxygen. The forced expiration directly aids in the emptying of the ventricles. How much the force of respiration may accomplish is shown by *Boehm*, who was able to maintain a fairly good rate of flow by forced artificial respiration, while the heart itself was not working actively.

3. The circulating chemical products of muscle work stimulate respiration and also the heart directly. Stokes and Oertel explain so the fact that muscular exercise, although increasing the work of the heart, often benefits the organ itself.

It must be added, however, that by prescribing exercises we do not always wish to raise the blood pressure in the arteries, but often to increase the rate of flow in the venous system alone without raising the general pressure. Now upon the right

selection of exercises will depend whether the heart is simply relieved and compensated or whether a real training of the heart is accomplished. For the first purpose, exercises with the assistance of a well-trained nurse or in a Zander institute are preferable; while for the latter, besides these, exercises such as mountain climbing after the manner of *Oertel* may be advisable.

V. OTHER INTERNAL DISEASES.

Among other internal organs the function of which may be restored or at least improved by gymnastics should be mentioned especially the lungs and pleuræ. Indications for such treatment may be either diseases of these organs themselves and their sequelæ or disturbances of the circulation sometimes accompanying such conditions. In chronic bronchitis, emphysema, asthma and pleuritis, breathing exercises have been recommended, and according to the special indication inspiration or expiration must be more favored. Resistance movements either with another person or with apparatus such as Zander's have been grouped into an elaborated system, and textbooks of physical therapeutics give careful prescriptions for this purpose.

The principles of such exercises are in a few words the following: Strengthening of the respiratory muscles to promote the deep breathing in order to force all parts of the lungs and pleuræ to take part in the function and also to improve the circulation within the lungs. Deep inspiration, together with resistance movements of the trunk and upper extremities, will favor the expectoration in chronic bronchitis and loosen adhesions in pleuritis. How much can be gained even in empyema is shown by a case now under treatment. A young fellow of eighteen years,

who had been operated upon for empyema of the left pleura six weeks before, was sent for treatment in the Zander department of the Massachusetts General Hospital. The wound was still discharging, so that daily dressing was necessary. His general constitution and especially his heart was very weak, the pulse-rate increasing from 100 to 120 by a few motions. On the left side the respiratory excursion was absent, while the right side made an excursion of $1\frac{3}{4}$ inches. The patient was prescribed very slight and slow active and passive breathing exercises which were connected with vibration and tapotement of the back and side and with asymmetrical resistance movements of the trunk and arms. In twelve days the wound was closed, the pulse dropped to 88 and became more stabile, the excursion of the left side was $\frac{1}{4}$ inch. In another week it had increased to $\frac{1}{2}$ inch, and it is now (three weeks later) 1 inch. The patient has become stronger and of better color.

As in stiff joints, the prognosis here depends upon organic changes. Strong fibrous adhesions or pleural callosities cannot be torn. Long-standing loss of elasticity of the lungs in emphysema cannot be cured, but in the early stages much can be done to avoid such conditions or at least retard their development.

Among other diseases which are amenable to active exercise treatment may be mentioned diabetes, obesity and constipation. The sugar-content is lessened by exercise, as *Kuelz, v. Mehring* and other competent authors have shown by exact experiments with their patients.

That obesity is reduced by muscular training is a well-known fact, only it needs some energy on the part of the patient. With a few weeks' exercises nothing may be expected, but for

months and years systematic and constant attention is necessary.

We know of no more satisfactory treatment of chronic constipation than careful and persistent exercise and massage for the development of the abdominal muscles.

We believe that in the future many conditions in which heretofore reliance has been largely placed upon drugs will be found to be satisfactorily amenable to treatment along the line of active muscular exercises as outlined in this paper. We also believe that more lasting results may be expected from these methods which call into action the restorative and conservative natural forces within the human body itself.

SAMUEL USHER, BOSTON